

METRICS AND MEASUREMENT

Name _____

In the chemistry classroom and lab, the metric system of measurement is used, so it is important to be able to convert from one unit to another.

mega	kilo	hecto	deca	Basic Unit	deci	centi	milli	micro
(M)	(k)	(h)	(da)	gram (g)	(d)	(c)	(m)	(μ)
1,000,000	1000	100	10	liter (L)	.1	.01	.001	.000001
10^6	10^3	10^2	10^1	meter (m)	10^{-1}	10^{-2}	10^{-3}	10^{-6}

The factor label method can be used to solve virtually any problem including changes in units. It is especially useful in making complex conversions dealing with concentrations and derived units.

Convert the following.

- 35 mL = _____ dL
- 950 g = _____ kg
- 275 mm = _____ cm
- 1,000 L = _____ kL
- 1,000 mL = _____ L
- 4,500 mg = _____ g
- 25 cm = _____ mm
- 0.005 kg = _____ dag
- 0.075 m = _____ cm
- 15 g = _____ mg

Solve the following problems. Write the answers in significant figures.

- 3 hrs = _____ sec
- 0.035 mg = _____ cg
- 5.5 kg = _____ lbs
- 2.5 yds = _____ in
- 1.3 yrs = _____ hr (1 yr = 365 days)
- 3 moles = _____ molecules (1 mole = 6.02×10^{23} molecules)
- 2.5×10^{24} molecules = _____ moles
- 5 moles = _____ liters (1 mole = 22.4 liters)
100. liters = _____ moles
50. liters = _____ molecules
- 5.0×10^{24} molecules = _____ liters
- 7.5×10^3 mL = _____ liters

Conversions

Unit Conversions Practice

Make the following conversions:

- 1) Convert 16.7 inches to *meters*
- 2) Convert 25 yards to *centimeters*
- 3) Convert 90 centuries to years
- 4) Convert 84 miles to kilometers
- 5) Convert 4.75 centimeters to *feet*
- 6) Convert 48,987 minutes to days
- 7) Convert 0.090 miles to *meters*
- 8) Convert 556 degrees Celsius to Kelvin

9) Convert 25 Kelvin to degrees Celsius

10) According to the Guinness book of Records, the heaviest baby ever born weighed 29 lbs 4 oz (29.25 lbs). What was the baby's mass in kg? (Historical note: The birth occurred in Effingham, IL in 1939. Due to respiratory problems, the baby died two hours later. The heaviest babies to survive weighed 22.5 lbs and were born in 1955 and 1982.)

11. One 1.6-oz package of cinnamon and spice instant oatmeal contains 34.0 g of carbohydrates. If you had instant oatmeal 6 days/week, how many ounces of carbohydrate would you consume in a week?

X
X
X

Heat and Temperature

DIRECTIONS: Write on the line at the right of each statement the number that makes the statement an equality when substituted for the corresponding number.

1. $30^{\circ}\text{C} = \underline{(1)} \text{ K}$ _____ 1
2. $-25^{\circ}\text{C} = \underline{(2)} \text{ K}$ _____ 2
3. $190\text{K} = \underline{(3)} ^{\circ}\text{C}$ _____ 3
4. $300\text{K} = \underline{(4)} ^{\circ}\text{C}$ _____ 4
5. $6500 \text{ cal} = \underline{(5)} \text{ kJ}$ _____ 5
6. $1.62 \text{ kJ} = \underline{(6)} \text{ kcal}$ _____ 6

DIRECTIONS: Write on the line at the right of each statement the letter preceding the word or expression that best completes the statement.

7. Determining whether an object feels hot or cold to the touch is a way of measuring its
(a) temperature; (b) heat; (c) density; (d) none of the above. _____ 7
8. The measurement using a thermometer is based on the (a) type of thermometer liquid;
(b) quantity of thermometer liquid; (c) uniform expansion or contraction of the thermometer
liquid; (d) thermometer liquid's color. _____ 8
9. Water freezes at (a) 273.15K ; (b) 100°C ; (c) 0K ; (d) 373.15K . _____ 9
10. The equation used to convert from the Celsius to Kelvin scale is (a) $T(\text{K}) = t(^{\circ}\text{C}) + 100$;
(b) $T(\text{K}) = t(^{\circ}\text{C}) + 273.15$; (c) $T(^{\circ}\text{C}) = t(\text{K}) + 100$; (d) $T(^{\circ}\text{C}) = t(\text{K}) + 273.15$. _____ 10
11. If two systems do not have heat flowing between them, they have the same (a) density;
(b) thermodynamic properties; (c) specific heat; (d) temperature. _____ 11
12. One calorie is the same amount of heat as 4.184 (a) joules; (b) Calories; (c) kilojoules;
(d) kilocalories. _____ 12

DIRECTIONS: Write the answer to questions 13–15 on the line to the right, and show your work in the space provided.

13. A 4.0-g sample of iron was heated from 0.0°C to 20.0°C , and was found to have absorbed
35.2 J of heat. Calculate the specific heat of this piece of iron. _____ 13
14. Calculate how much heat a copper sample will gain if its specific heat is $0.384 \text{ J}/(\text{g} \cdot ^{\circ}\text{C})$, its mass
is 8.00 g, and it is heated from 10.0°C to 40.0°C . _____ 14
15. Determine the specific heat of a material if a 6 g sample absorbs 50 J as it is heated from
 30°C to 50°C . _____ 15

X

SCIENTIFIC NOTATION

Name _____

Scientists very often deal with very small and very large numbers, which can lead to a lot of confusion when counting zeros! We have learned to express these numbers as powers of 10.

Scientific notation takes the form of $M \times 10^n$ where $1 \leq M < 10$ and "n" represents the number of decimal places to be moved. Positive n indicates the standard form is larger than zero whereas negative n would indicate a number smaller than zero.

Example 1: Convert 1,500,000 to scientific notation.
We move the decimal point so that there is only one digit to its left, a total of 6 places.

$$1,500,000 = 1.5 \times 10^6$$

Example 2: Convert 0.000025 to scientific notation.
For this, we move the decimal point 5 places to the right.

$$0.000025 = 2.5 \times 10^{-5}$$

(Note that when a number starts out less than one, the exponent is always negative.)

Convert the following to scientific notation.

1. $0.005 =$ _____

6. $0.25 =$ _____

2. $5,050 =$ _____

7. $0.025 =$ _____

3. $0.0008 =$ _____

8. $0.0025 =$ _____

4. $1,000 =$ _____

9. $500 =$ _____

5. $1,000,000 =$ _____

10. $5,000 =$ _____

Convert the following to standard notation.

1. $1.5 \times 10^3 =$ _____

6. $3.35 \times 10^{-1} =$ _____

2. $1.5 \times 10^{-3} =$ _____

7. $1.2 \times 10^{-4} =$ _____

3. $3.75 \times 10^{-2} =$ _____

8. $1 \times 10^4 =$ _____

4. $3.75 \times 10^2 =$ _____

9. $1 \times 10^{-1} =$ _____

5. $2.2 \times 10^5 =$ _____

10. $4 \times 10^0 =$ _____

PERCENTAGE ERROR

Name _____

Percentage error is a way for scientists to express how far off a laboratory value is from the commonly accepted value.

The formula is:

$$\begin{array}{l} \% \text{ error} = \left| \frac{\text{Accepted Value} - \text{Experimental Value}}{\text{Accepted Value}} \right| \times 100 \\ \rightarrow \\ \text{absolute value} \end{array}$$

Determine the percentage error in the following problems.

1. Experimental Value = 1.24 g
Accepted Value = 1.30 g

Answer: _____

2. Experimental Value = 1.24×10^2 g
Accepted Value = 9.98×10^3 g

Answer: _____

3. Experimental Value = 252 mL
Accepted Value = 225 mL

Answer: _____

4. Experimental Value = 22.2 L
Accepted Value = 22.4 L

Answer: _____

5. Experimental Value = 125.2 mg
Accepted Value = 124.8 mg

Answer: _____

Density Problems

The density of Lead (Pb) is 11.35 g/cm^3 . If you have a block of lead that is 3.00 cm high, 15.00 cm long, and 6.00 cm wide, how much mass does it have?

A bottle of mercury (Hg) has a mass of 176.8 grams and has a volume of 13.0 ml. What is the density of mercury?

How much does 25.0 ml of gasoline weigh if the density of gas is 0.670 g/ml ?

Calculate the density of a sample of copper if it has a mass of 13.0 g and 1.46 cm^3 ?

A cylinder of copper (Cu) has a diameter of 1.00 cm and a height of 6.00 cm. What is the cylinder's mass?

What would the volume be of a beaker of ethanol be if it had a mass of 500. g. (D of ethanol is 0.806 g/ml)

X

Harder Problems Chapter 2AF- Solve the following problems making sure to show all your work with units.

1. A river is flowing at 15000 gal/hour. How mL/s is this rate of flow?

2. You pass a road sign saying "New York 112 km." If you drive at a constant speed of 65 mph, how long should it take you to reach New York?

3. The density of osmium (the densest metal) is 22.57 g/cm^3 . If a 1.00 kg rectangular block of osmium has two dimensions of 4.00 cm and 4.00 cm, calculate the third dimension.

4. A copper refinery produces a copper ingot weighing 150 lb. If the copper is drawn into wire whose diameter is 8.25 mm, how many feet of copper can be obtained from the ingot. The density of copper is 8.94 g/cm^3 ?

Harder Problems Chapter 2

1. A copper refinery produces a copper ingot weighing 150 lb. If the copper is drawn into wire whose diameter is 8.25 mm, how many feet of copper can be obtained from the ingot. The density of copper is 8.94 g/cm^3 ?
2. Large beds of rocks are used in some solar-heat homes to store heat. Calculate how many Calories of heat that are absorbed by 50.0 kg of rocks if their temperature increases by 12.0°C ? (The specific heat of the rocks is $0.82 \text{ J/g}^\circ\text{C}$)
3. When two objects of different heat content come in contact, the heat lost by one object equals the heat gained by another. If a 15.00 g sample of hot copper is dipped into 100.0 mL of water at 20.0°C , both the water and copper reach a final temperature of 45.0°C . What was the initial temperature of the hot copper metal? ($C_{\text{Cu}} = 0.385 \text{ J/g}^\circ\text{C}$)
4. Gold is combined with other metals to increase its hardness in making jewelry. Consider a piece of jewelry that weighs 9.85 g and has a volume of 0.675 cm^3 . The jewelry contains only gold and silver, whose densities are 19.3 g/cm^3 and 10.5 g/cm^3 , respectively. Assuming the total volume of the jewelry is the sum of the volumes of the gold and silver that it contains, calculate the percentage of gold (by mass) in the jewelry.

DIRECTIONS: Write on the line at the right of each statement the number that best completes the statement when substituted for the corresponding number.

1. 100 mL = (1) dL
2. 10^{-2} m = (2) mm
3. 0.25 g = (3) mg
4. 0.06 cm = (4) mm
5. 2.04 L = (5) mL

_____ 1
_____ 2
_____ 3
_____ 4
_____ 5

DIRECTIONS: Write on the line at the right of each statement the letter preceding the word or expression that best completes the statement.

6. The metric prefix deci- (symbol d) represents the factor (a) 10^{-1} ; (b) 10^{-2} ; (c) 10^{-3} ; (d) 1^{-1} .
7. The internationally accepted units for the fundamental quantities of length and mass are (a) centimeter and gram; (b) meter and gram; (c) centimeter and kilogram; (d) meter and kilogram.
8. The metric unit for length that is closest to the thickness of a dime is (a) micrometer; (b) millimeter; (c) centimeter; (d) decimeter.
9. If the density of a substance is multiplied by the volume, and the product obtained is divided by the number of grams per mole, the unit for the answer that results will be (a) liters per mole; (b) mole; (c) grams; (d) moles per gram.
10. Starting with 365 days per year, you can calculate the number of seconds in a year by multiplying the number of hours per day and (a) dividing by min/h and multiplying by s/min; (b) dividing by both min/h and s/min; (c) multiplying by both min/h and s/min; (d) multiplying by min/h and dividing by s/min.
11. The quantity expressed by m^3 is (a) length; (b) mass; (c) volume; (d) density.
12. The liter is a volume equal to (a) 1000 mL; (b) 1 dm^3 ; (c) 10^3 cm^3 ; (d) all of the above.

_____ 6
_____ 7
_____ 8
_____ 9
_____ 10
_____ 11
_____ 12

DIRECTIONS: Write the number of significant figures in each measurement on the line to the right.

1. 0.000305 kg
2. 32.2 m
3. 240.020 km
4. 30.00 dL
5. 210 g

_____ 1
_____ 2
_____ 3
_____ 4
_____ 5

DIRECTIONS: Write the number that makes each statement an equality on the line to the right. Round your answer to the correct number of significant figures, and show your work in the space provided.

6. $1.27 \text{ cm} \times 1.3 \text{ cm} \times 2.5 \text{ cm} = \underline{(6)} \text{ cm}^3$

_____ 6

7. 5.7 m divided by 2 m = (7) m

_____ 7

8. $214.53 \text{ km} + 32 \text{ km} = \underline{(8)} \text{ km}$

_____ 8

9. $12 \text{ cm} \times 5.7 \text{ cm} = \underline{(9)} \text{ cm}^2$

_____ 9

10. $0.13 \text{ g} + 1.7 \text{ g} + 0.562 \text{ g} = \underline{(10)} \text{ g}$

_____ 10

DIRECTIONS: Write each number expressed in scientific notation on the line to the right.

- 11 $0.000065 \text{ cm} =$ _____ cm 11
- 12 $0.0930 \text{ m} =$ _____ m 12
- 13 $5900 \text{ km} =$ _____ km 13

DIRECTIONS: Write on the line at the right of each statement the letter preceding the word or expression that best completes the statement.

- 14 Uncertainty in scientific measurement due to poor precision can result from (a) the standard being too strict; (b) human error; (c) limitations of the measuring device; (d) both b and c. _____ 14
- 15 A chemist who frequently carries out a complex experiment is likely to have a great deal of (a) accuracy, but not any precision; (b) accuracy; (c) precision; (d) precision, but not any accuracy. _____ 15

DIRECTIONS: Use the four-step method to solve questions 1–4. Write your answer on the line at the right, and show your work in the space provided.

- 16 What is the volume of a cube that measures 2.5 cm on a side? _____ 16
- 17 If one inch equals 2.54 centimeters, how many centimeters equal one yard? _____ 17
- 18 How many minutes are in two weeks? _____ 18
- 19 You expect to drive an average speed of 79.0 km/h on a four hour trip. How far will you travel? _____ 19

DIRECTIONS: Write the answer to questions 5–10 on the line to the right, and show your work in the space provided. Questions 5–10 refer to the equation for calculating density, or $d = m/V$.

- 20 In the equation for density, the relationship between mass and volume represents what type of proportion? _____ 20
- 21 In the formula for density, which variables have a direct proportionality? _____ 21
- 22 In the formula for density, which measurement is a constant? _____ 22
- 23 When mass of a substance equals 1 g and its volume is 1.5 cm^3 , what is its density? _____ 23
- 24 What is the volume of a 3 gram sample of a substance whose density equals 1.5 g/cm^3 ? _____ 24
- 25 This equation will graph as what type of line? _____ 25

DIRECTIONS: Write the answer to questions 13–15 on the line to the right, and show your work in the space provided.

- 26 Aluminum has a density of 2.70 g/cm^3 . Calculate the mass of a solid piece of aluminum whose volume is 1.50 cm^3 . _____ 26
- 27 A 5.00-cm^3 sample of gold has a mass of 96.5 grams. Calculate the density of gold. _____ 27
- 28 Calculate the density of 37.72 g of matter whose volume is 6.8 cm^3 . _____ 28